



Recent Tevatron Operations + Last Week's Failure in D3



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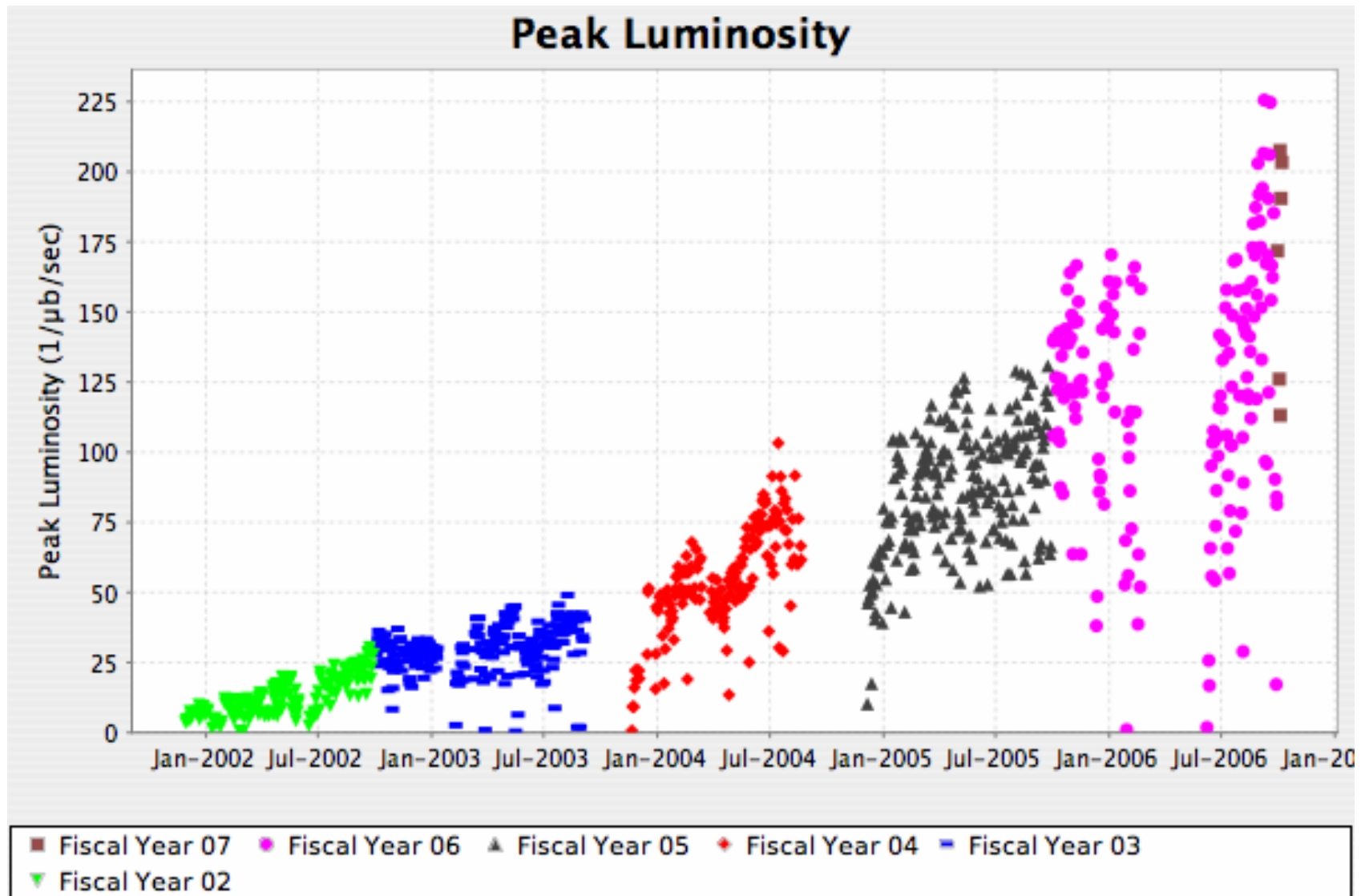
- Notable achievements since the long shutdown ended
 - Delivered lumi / week = 33.3 pb^{-1}
 - Delivered lumi from Aug 28-Sep 3 $\approx 119 \text{ pb}^{-1}$
 - Peak luminosity = $238 \cdot 10^{30} \text{ cm}^{-2} \text{ s}^{-1}$
 - Record # pbars at start HEP $\approx 2870 \cdot 10^9$

Comparison between pre- and post-shutdown record stores			
Store	Initial Lumi* [$10^{30} \text{ cm}^{-2} \text{ s}^{-1}$]	# protons [10^9]	# pbars [10^9]
4581	180	8480	2340
4964	238	9300	2870
$\Delta(4581 \rightarrow 4964)$	+32%	+9.5%	+22.5%

* Includes +6% increase for D0 lumi scale correction



Run II Peak Luminosities

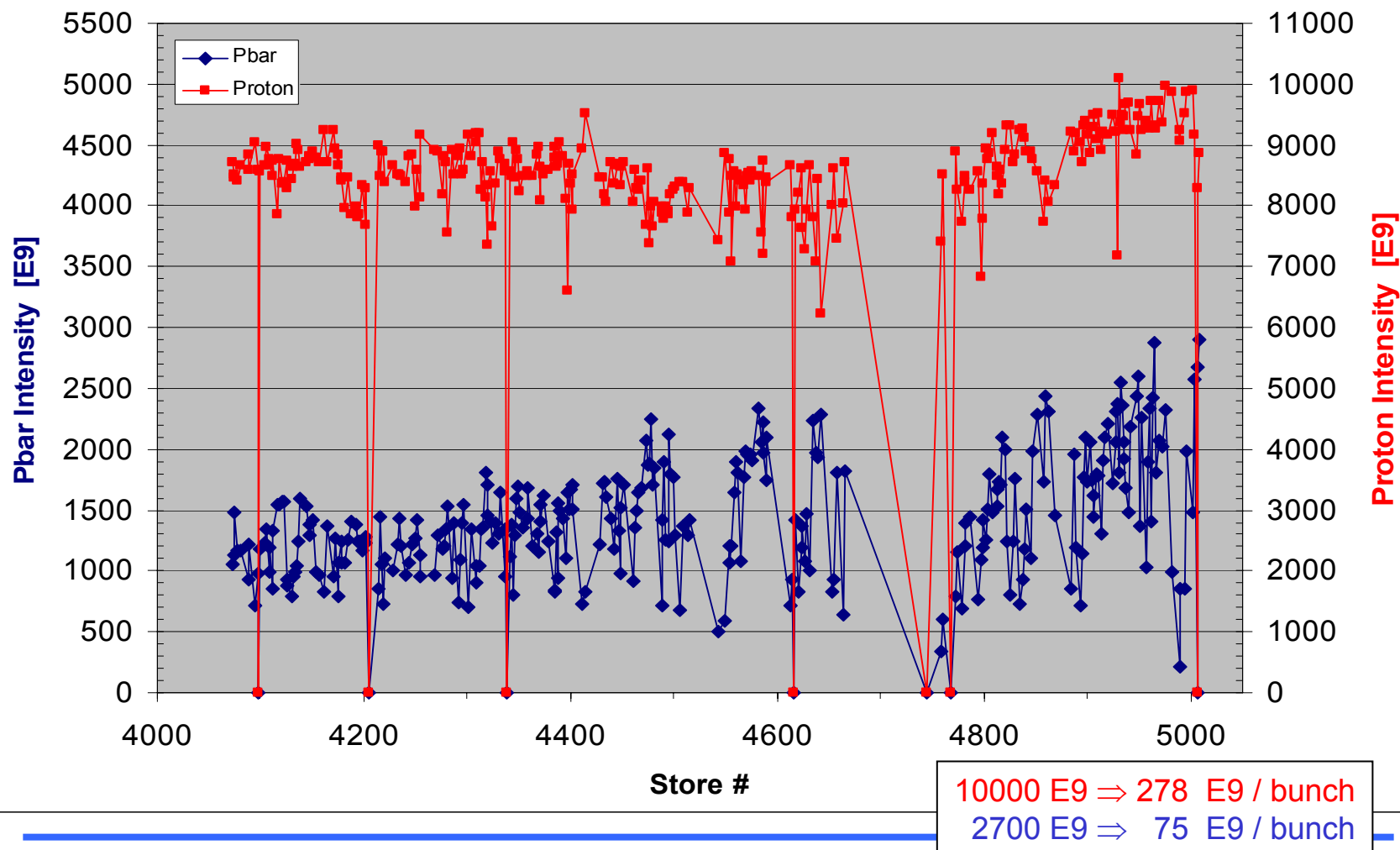




Increasing Beam Intensities



Beam Intensities at Start of HEP

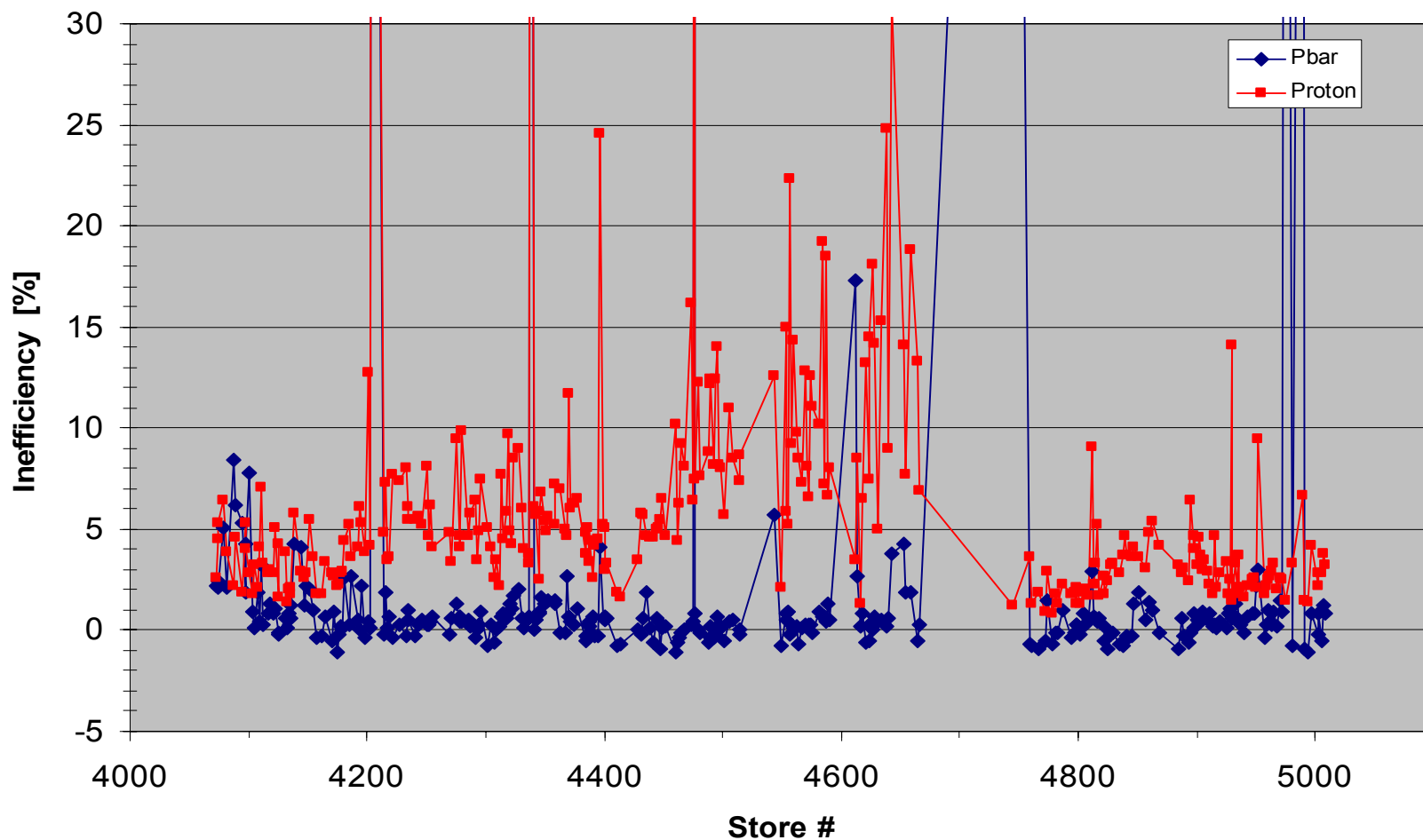




Reduced Tevatron Beam Loss @ 150 GeV



Bunched Beam Inefficiency @ 150 GeV

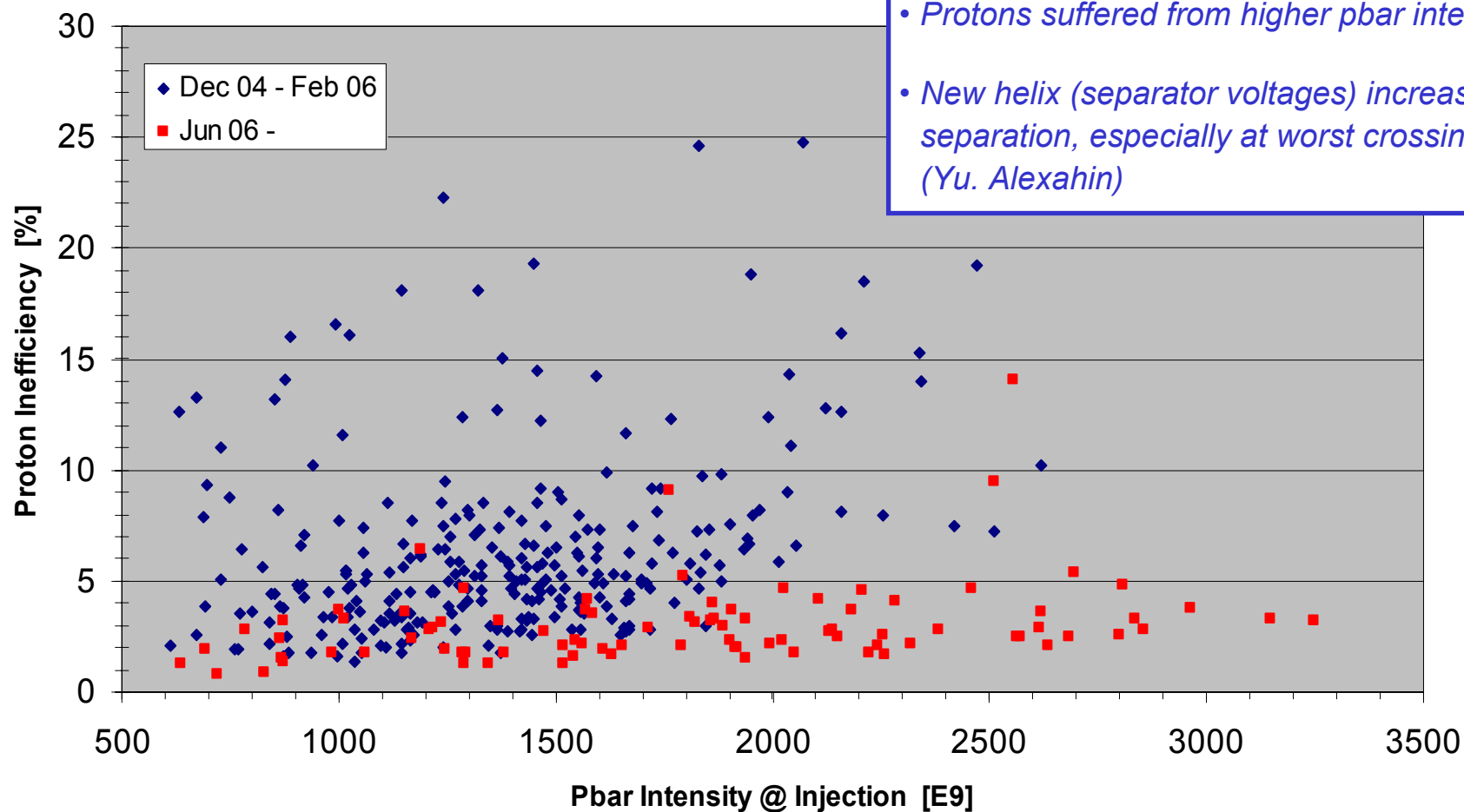




Reduced Beam-Beam Effects @ 150 GeV



Proton Inefficiency @ 150 GeV





Tevatron Luminosity Lifetimes



- Long-range beam-beam effects degrade luminosity lifetime + integral
 - Nearest parasitic crossings (≈ 59 m from IPs) especially bad
- During shutdown, additional separators installed to increase separation
 - More separation \Rightarrow reduced beam-beam effects

Beam separation near IPs (in σ 's)

	B0 US	B0 DS	D0 US	D0 DS
Before	5.4	5.6	5.0	5.2
After	6.4	5.8	6.2	5.6

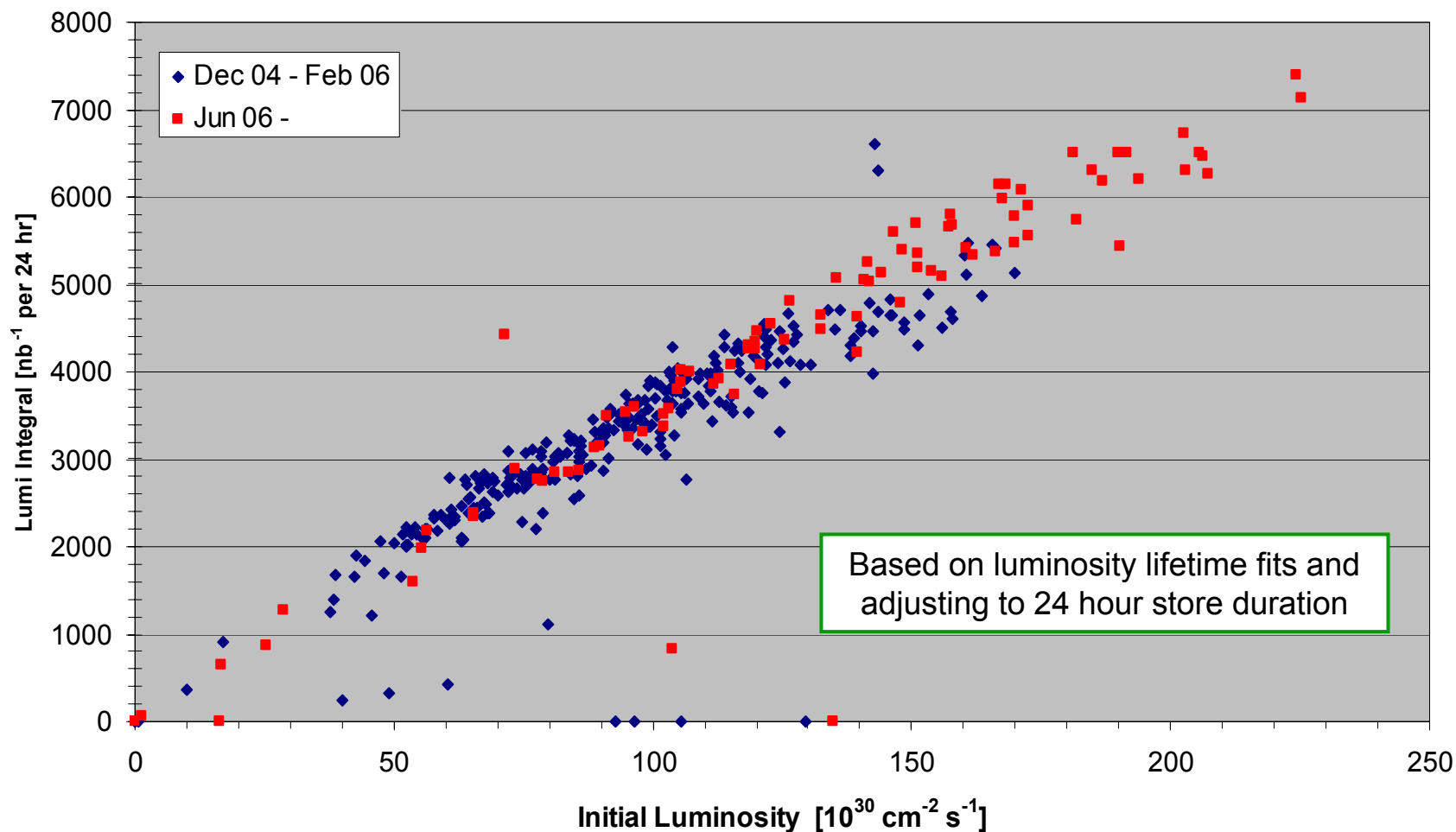
- $\sim 20\%$ increase @ upstream IP
 - Not as much @ downstream IP
- Thanks to TD for helping us with the separators
- Luminosity lifetime improved $\sim 20\%$ compared to pre-shutdown running
 - Increased integrated luminosity per store (for given store length)



Better Lifetime \Rightarrow More Delivered Luminosity



Normalized Lumi Integral / 24 hr vs Initial Luminosity





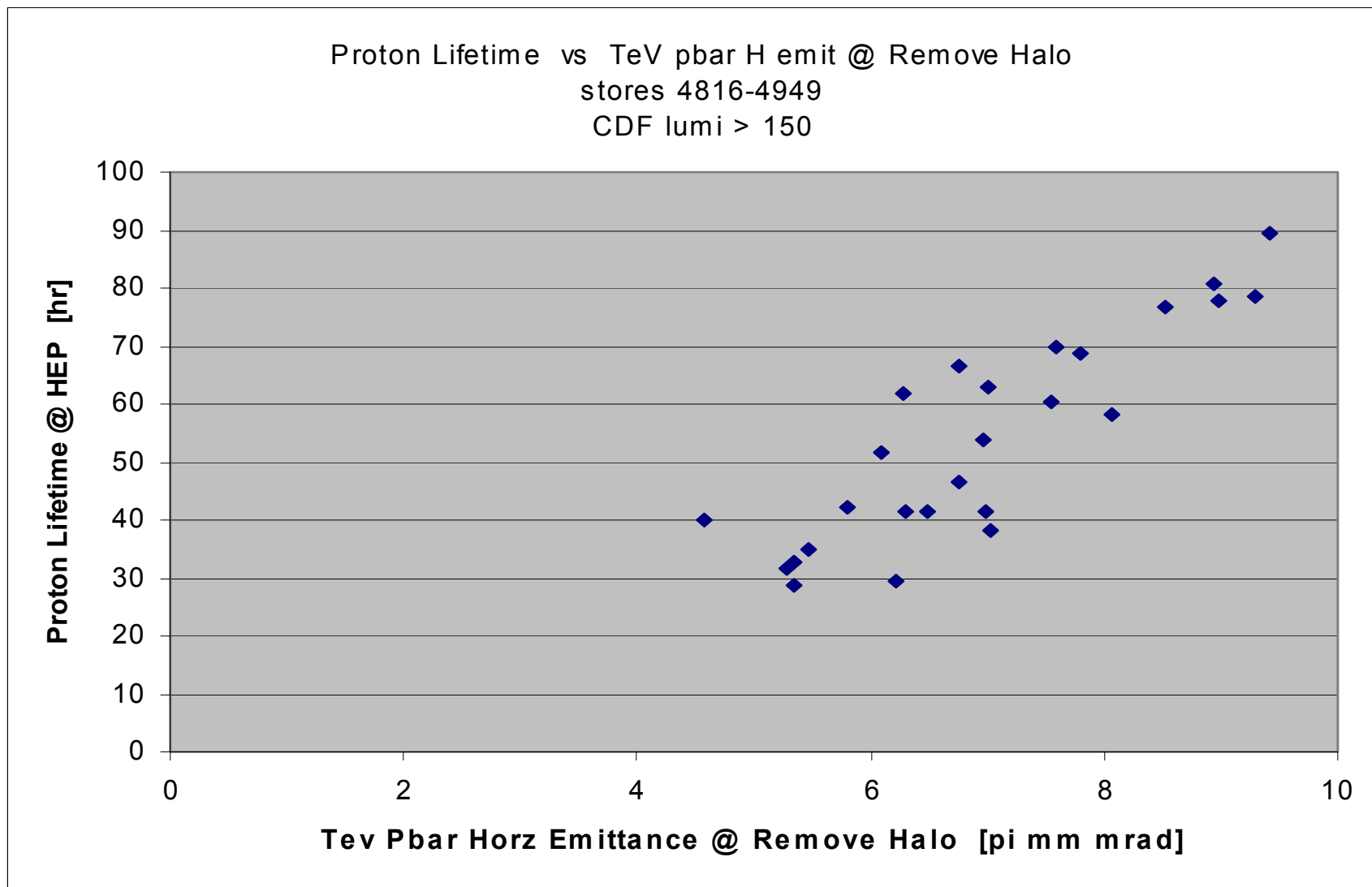
Smaller Pbar Emittances from Recycler



- New Recycler tune reduced emittance growth rate (*mid-August*)
 - ⇒ Brighter (smaller emittance) pbars delivered to Tevatron
 - ⇒ **Higher instantaneous luminosity for same number of pbars...**
 - ⇒ **...consequently lower luminosity lifetime** (but still worth it for $\int L$)
 - ⇒ Smaller emittances also improves pbar and proton efficiencies in Tevatron
 - ⇒ Proton lifetime in collisions decreased as well



Proton Lifetime @ HEP vs Pbar Horz Emittance

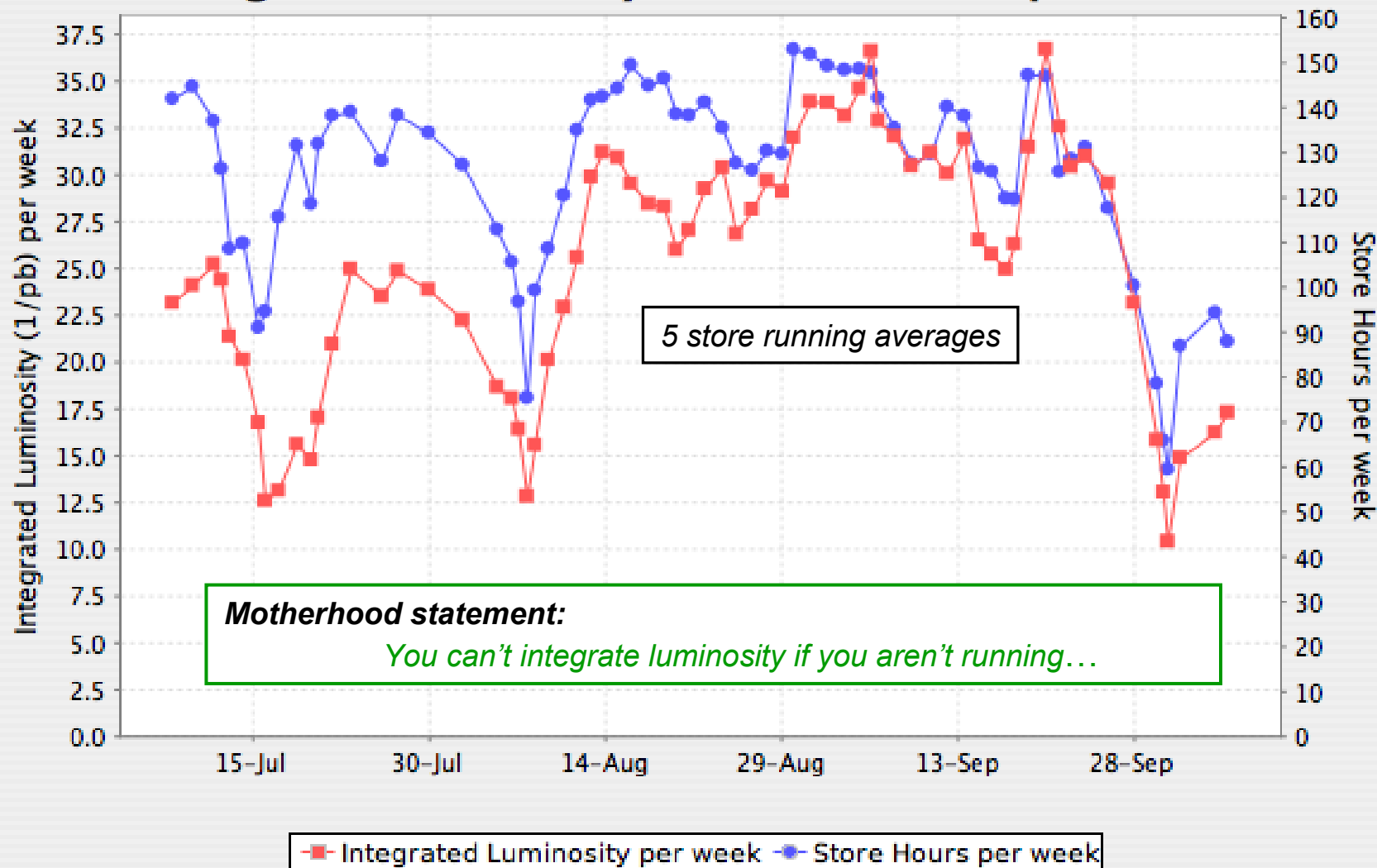




Reliability



Integrated Luminosity and Store Hours per week





Summary



- Record running in August/September thanks to performance and reliability of all machines
 - More beam to HEP and improved luminosity lifetime in Tevatron
 - More protons on pbar target (Linac / Booster / Main Injector)
 - Near record pbar stacking rates (Debuncher / Accumulator)
 - Smaller pbar emittances from Recycler
 - Good reliability and luck to avoid (most of) Mother Nature's wrath



Component Failure in D3

(we need less expensive mouse traps)



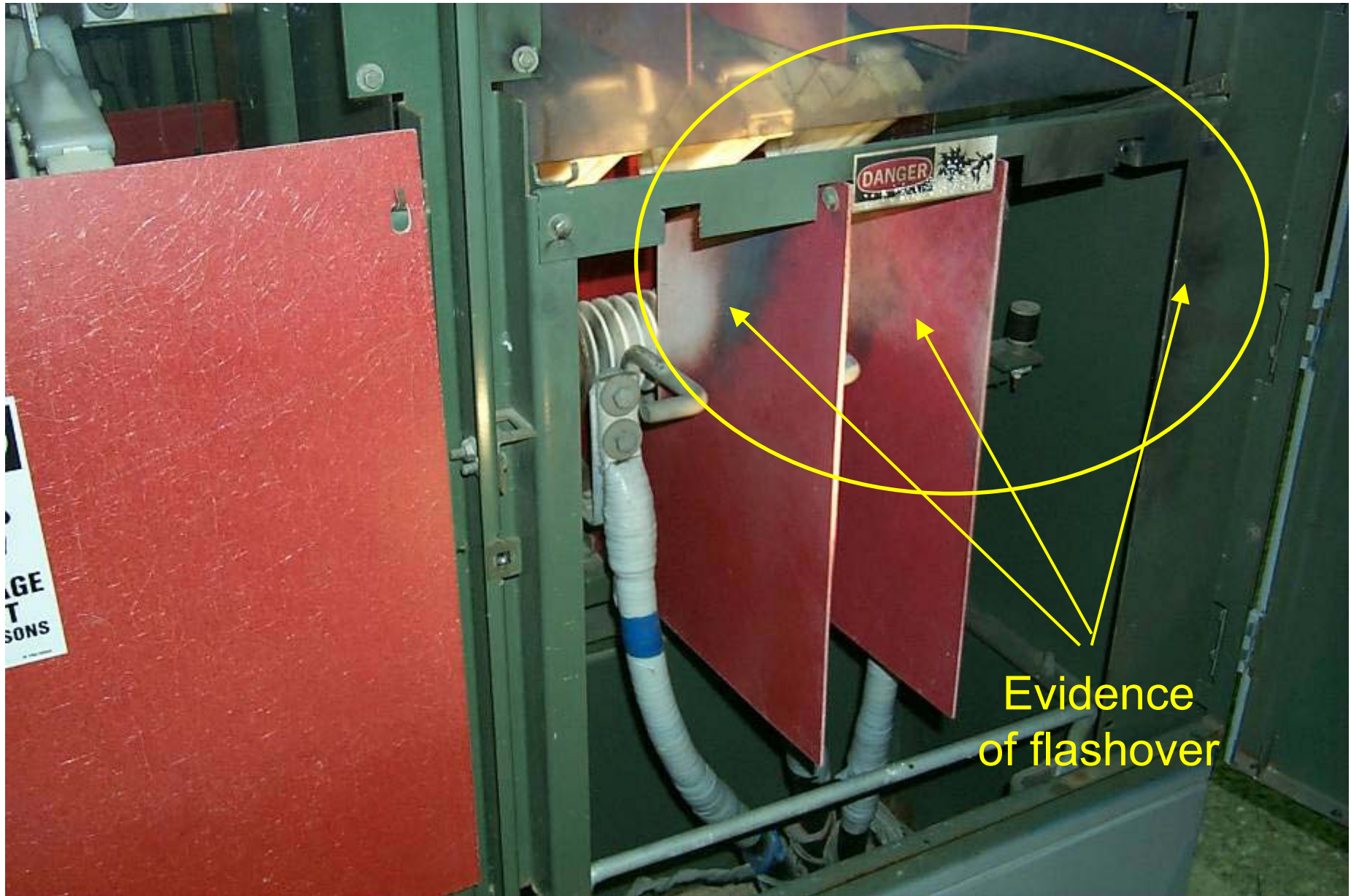


The Chain of Events



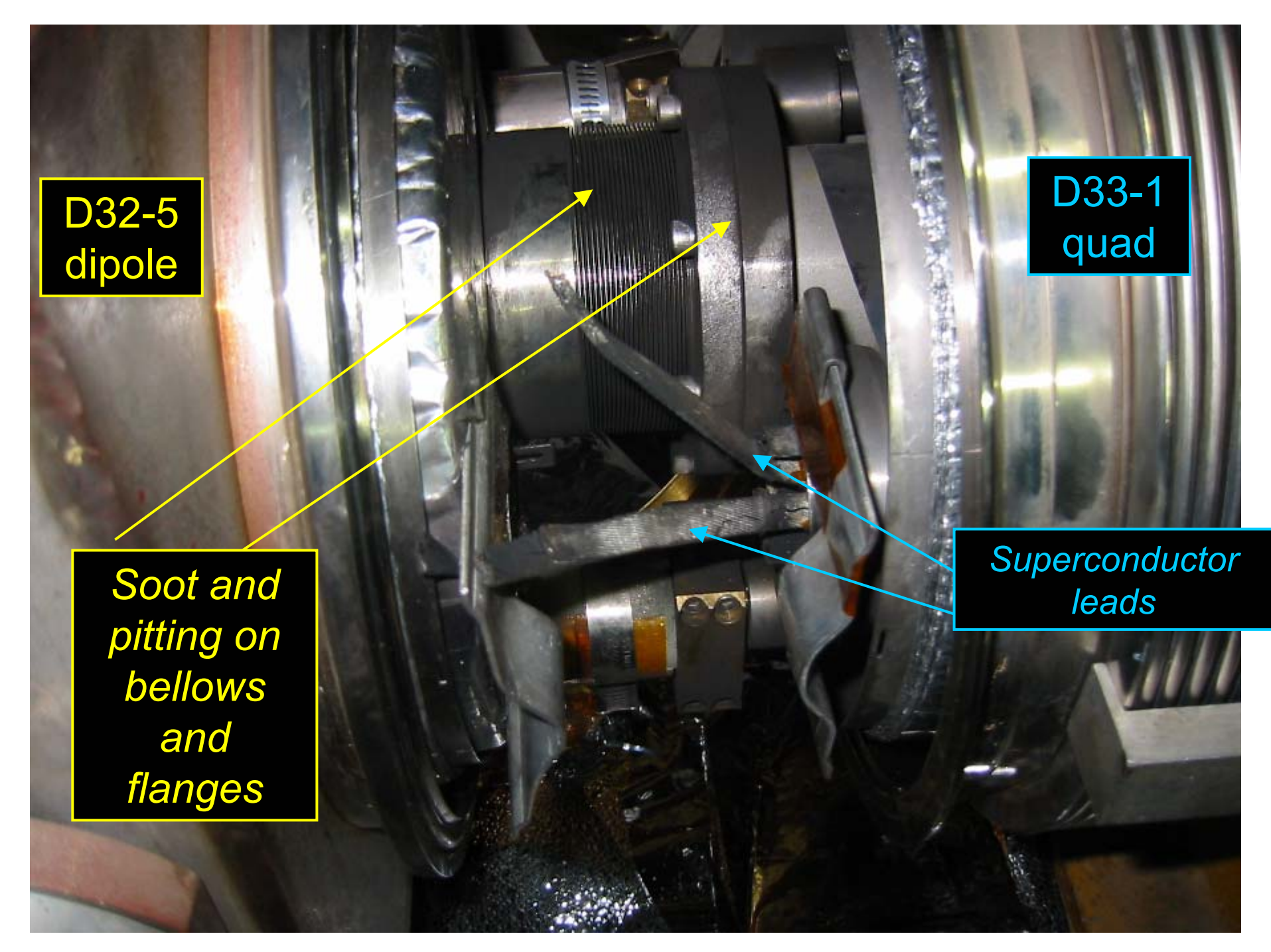
- HEP store 5008 happily spinning
 - Record # pbars injected into Tev, record # pbars reach HEP start
- Mouse seeks Feeder 46B cubicle as possible new, cozy home
 - Flashover + resulting nasty power glitch affects many systems
 - Many UPS units switched over
- Tevatron ramp begins to dump on A2 power supply trip
 - Beams aborted cleanly
- 1.2 sec into ramp dump, D3 QPM reboots (Quench Protection Monitor)
 - Why? Glitch not filtered out by UPS? UPS tested fine later...
 - As designed, QPM fired heaters, generating whole-house quench
- ≈ 4 sec into ramp dump, ground fault developed in D3
 - D32-5 dipole failed

Feeder 46B Cubicle near D0



The Culprit





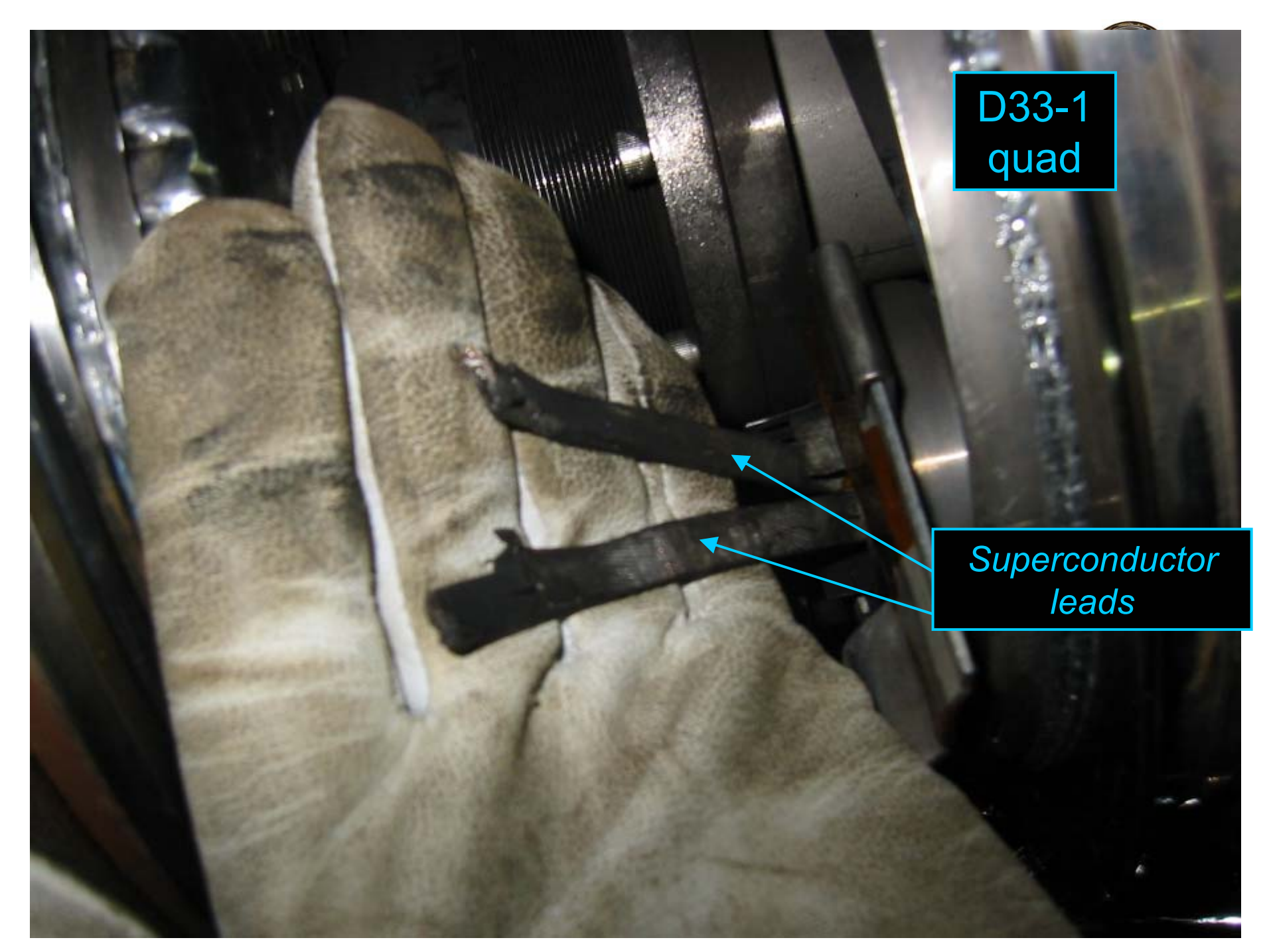
A close-up photograph of a particle accelerator component assembly. The image shows various metallic parts, including a bellows and flanges. Two yellow arrows point from the 'D32-5 dipole' label to the bellows and flanges. Two blue arrows point from the 'Superconductor leads' label to the leads. The 'D33-1 quad' label is also present. The overall scene is dimly lit, with some reflections on the metallic surfaces.

D32-5
dipole

D33-1
quad

*Soot and
pitting on
bellows
and
flanges*

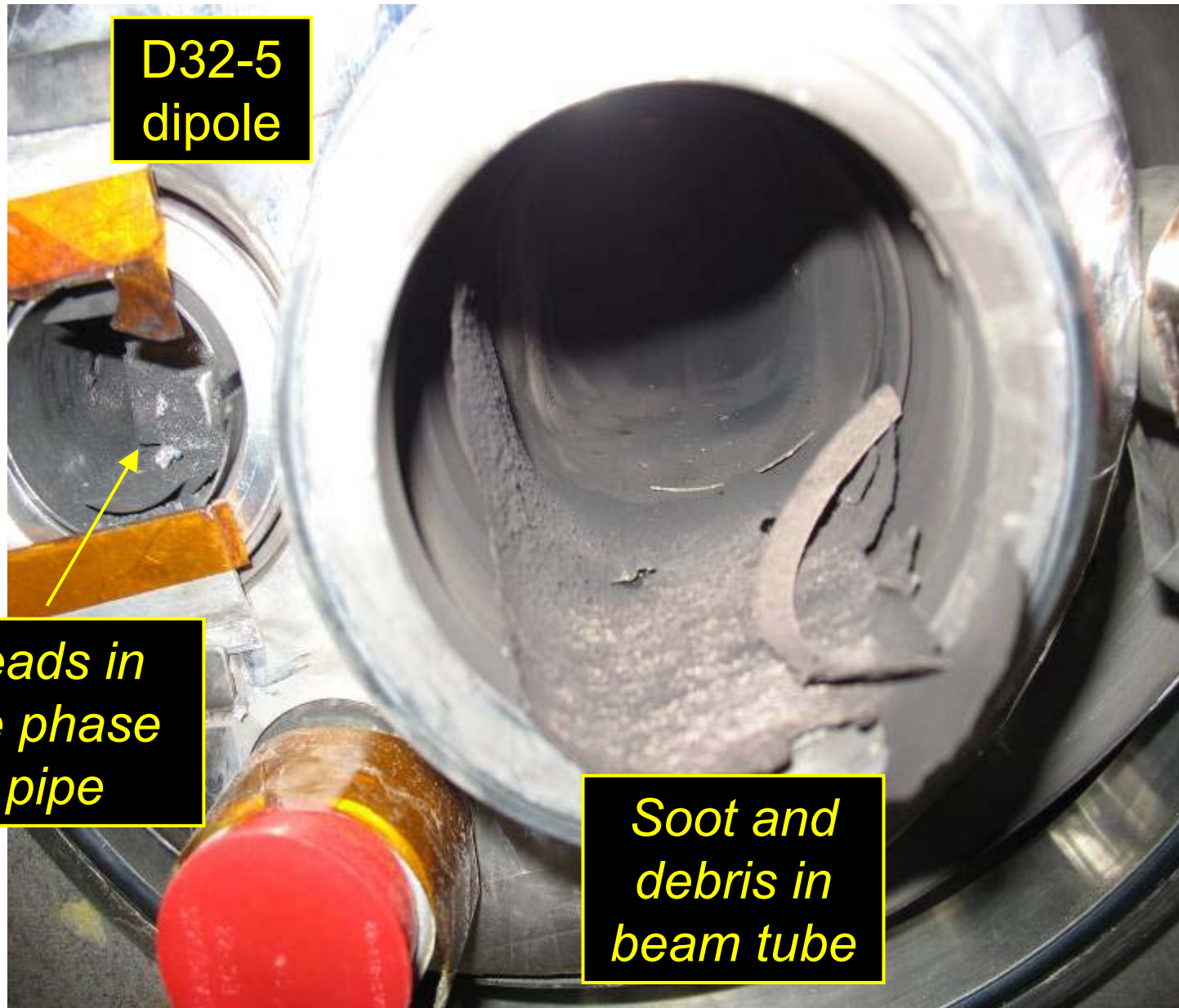
*Superconductor
leads*

A close-up photograph of a cryogenic system. Two dark, cylindrical superconductor leads are positioned horizontally across a large, light-colored, textured cryogenic shield. The shield has a vertical white stripe on its left side. The background shows metallic components of the cryostat, including a corrugated metal bellows and various structural plates. Two blue arrows point from the 'Superconductor leads' label to the two dark leads.

D33-1
quad

*Superconductor
leads*

D32-5 Dipole



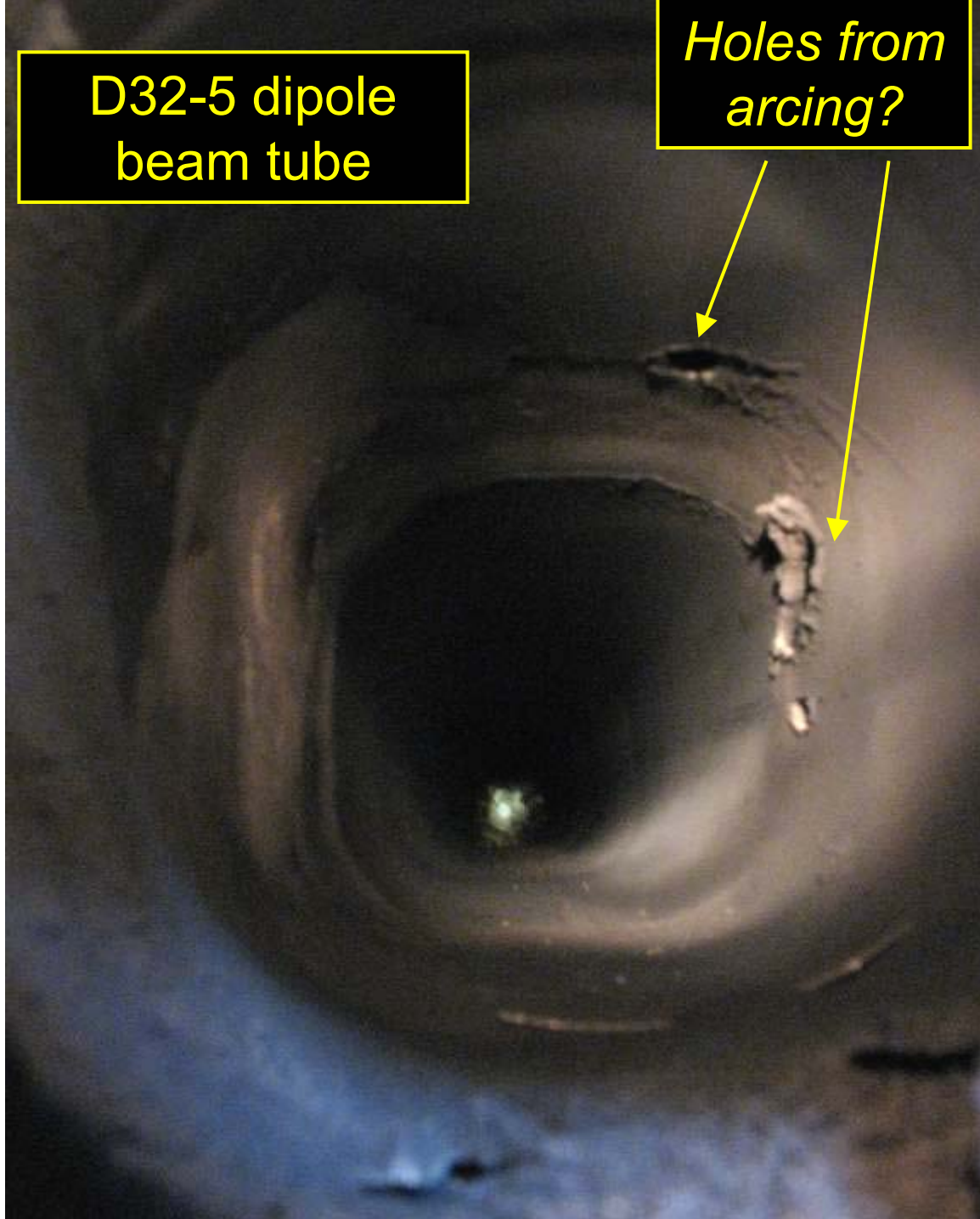
D32-5
dipole

*No leads in
single phase
He pipe*

*Soot and
debris in
beam tube*

D32-5 dipole
beam tube

*Holes from
arcing?*





The Aftermath



- Why that failure now? Speculate that a problem was lurking there...
 - Mechanical stresses from this quench enough to cause failure
 - D3 quenches infrequent – last one was Sep 11, 2002
- What is being replaced?
 - D32-5 dipole and D33-1 quadrupole
 - D35 spool package (broken dipole corrector, unrelated to this failure)
- Helium and “soot” in beam tube
 - Sucked into beam pipe from single phase line after arc-through
 - Leaky isolation valves between adjacent sectors...D1-D2-D3-D4
 - Complicated vacuum recovery
 - Swabbed out $\geq 10(?)$ magnets – required moving into aisle
 - Concern about separators
 - RGA scans show plenty of helium, but little carbon or hydrocarbons
 - More optimistic now, still want to power them up soon to check
 - Will need time for conditioning, can be done during cool-down